PAINT ROLLER WITH FLEXURE JOINT

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of United States Application Serial No. 09/490,417, entitled "Paint Roller with Flexure Joint" filed January 24, 2000.

FIELD OF THE INVENTION

The invention relates to paint rollers.

BACKGROUND OF THE INVENTION

Hand-held paint rollers are commonly employed to apply paint to large flat surfaces such as the interior walls of a room and the exterior siding of a residence. Standard paint rollers include a handle, a U-shaped shaft connected to a longitudinal end of the handle, and a tube-receiving frame rotatably connected to the free end of the shaft. The tube-receiving frame is sized to selectively receive and maintain a tubular paint applicator.

By employing a U-shaped shaft, the standard paint roller centrally positions the tubular paint applicator perpendicular to the longitudinal axis of the handle. This orientation allows a person using the paint roller use a painting motion generally parallel to the axis of the user's forearm.

While the U-shaped shaft provides an ergonomic orientation of the handle relative to the tubular paint applicator, the shaft possesses some drawbacks. For example, the U-shaped configuration of the shaft renders it difficult to apply paint to a high horizontal joint, such as the joint between a wall and the ceiling in a room. Because the tubular paint applicator is

cylindrical, the applicator cannot contact the wall and/or ceiling within the joint when the applicator is oriented parallel to the joint (*i.e.,* the applicator is rolled towards and away from the joint). Paint can be applied within the joint by orienting the applicator perpendicular to the joint and positioning the free end of the applicator into the joint (*i.e.,* the applicator is rolled along the joint). However, because the U-shaped shaft orientates the tubular paint applicator perpendicular to the handle, the user's forearm must be positioned in-line with the rolling direction of the applicator, thereby requiring the user to be elevated and paint from an awkward and uncomfortable position when painting an elevated horizontal joint.

Other drawbacks associated with the U-shaped handle occur when an elongated handle is employed to allow painting of elevated surfaces without use of a ladder or scaffolding. One such drawback is the difficulty in maintaining a distance between the handle and the vertical surface to be painted, which is sufficient to prevent the handle from contacting the surface and marking the surface. This problem is of particular concern as the length of the elongated handle increases because of the arch created in the elongated handle from the forward force applied in order to maintain the applicator in contact with the surface.

Accordingly, a need exists for an inexpensive paint roller capable of ergonomically allowing the painting of vertical and horizontal surfaces, including elevated vertical and horizontal surfaces, and vertical and horizontal joints, including elevated vertical and horizontal joints, while standing comfortably on the ground at all times.

SUMMARY OF THE INVENTION

The invention is a paint roller having a handle, a shaft, a functional element secured to a second end of the shaft and a means for repositioning the shaft and functional element relative to the handle. The repositioning means is interposed between and connects a second end of the handle and a first end of the shaft, and is configured to selectively position the functional element relative to the handle by providing a disengaged condition permitting repositioning of the shaft relative to the handle in at least two degrees of freedom, and an engaged condition

preventing repositioning of the shaft relative to the handle. The engaged condition can be achieved with the shaft in at least two different positions relative to the handle.

In a preferred embodiment, the repositioning means is a flexure joint which includes a spherical member, a receiving member configured and arranged to maintain and selectively engage the spherical member, and a connector in communication with the receiving member for releasably locking the spherical member in position as between at least a first locked position and a second locked position relative to the receiving member. Repositioning of the spherical member as between the first and second locked positions is effective for repositioning the shaft relative to the handle as between a first locked position and a second locked position.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of a first embodiment of a paint roller in accordance with the present invention wherein the shaft is oriented in a first longitudinally aligned position relative to the handle.

Figure 2 is a plan view of the paint roller shown in Figure 1 wherein the shaft is oriented in a second angularly displace position relative to the handle.

Figure 3 is a front view of the receiving member portion of the paint roller shown in Figure 1.

Figure 4 is a left side view of the receiving member shown in Figure 3.

Figure 5 is an exploded plan view of a second embodiment of a paint roller in accordance with the present invention.

Figure 6 is a front view of the handle shown in Figure 5.

Figure 7 is an end view of the first end of the handle shown in Figure 5.

Figure 8 is front view of the receiving member shown in Figure 5.

Figure 9 is a right side view of the receiving member shown in Figure 5.

Figure 10 is a left side view of the receiving member shown in Figure 5.

Figure 11 is a front view of the receiving member shown in Figure 5 with portions of the receiving member removed to depict the transverse bores extending through the receiving member.

Figure 12 is a front view of the spherical member shown in Figure 5.

Figure 13 is a side view of the spherical member shown in Figure 5.

Figure 14 is a front view of the fully assembled flexure joint shown in Figure 13.

Figure 15 is a right side view of the fully assembled flexure joint shown in Figure 13.

Figure 16 is a left side view of the fully assembled flexure joint shown in Figure 13.

Figure 17 is a front view of the assembled shaft and locking mechanism shown in Figure 5.

DETAILED DESCRIPTION OF THE INVENTION

Nomenclature

10 Paint Roller

20	Handle
20x	Longitudinal Axis of Handle
21	First End of Handle
22	Second End of Handle
23	Grip Portion of Handle
24	Neck Portion of Handle
29	Longitudinal Bore in Handle
30	Shaft
31	First End Section of Shaft
32	Second End Section of Shaft
33	U-Shaped Section of Shaft
40	Locking Mechanism
41	Distal End of Locking Mechanism
50	Flexure Joint
60	Spherical Member
60x	Longitudinal Axis of Spherical Member
60y	Latitudinal Axis of Spherical Member
60z	Transverse Axis of Spherical Member
70	Collar
79	Threaded Bore in Collar
80	Receiving Member
80x	Longitudinal Axis of Receiving Member
80y	Latitudinal Axis of Receiving Member
80z	Transverse Axis of Receiving Member
81	Shoulder Portion of Receiving Member
82	Clamping Portion of Receiving Member
83	First Arm
83d	Distal End of First Arm
83p	Proximal End of First Arm
83i	Inner Surface of First Arm
83o	Outer Surface of First Arm

84	Second Arm
84d	Distal End of Second Arm
84p	Proximal End of Second Arm
84i	Inner Surface of Second Arm
84o	Outer Surface of Second Arm
85	Threaded Longitudinal Bore in Shoulder Portion of Receiving Member
86	Transverse Pin Passage in Shoulder Portion of Receiving Member
87	Gap Separating First and Second Arms
87d	Distal Region of Gap
87m	Middle Region of Gap
87p	Proximal Region of Gap
88'	Aperture Through First Arm
88"	Aperture Through Second Arm
89'	Connector Receiving Bore Through First Arm
89"	Connector Receiving Threaded Bore in Second Arm
90'	Spacing Adjustment Mechanism Receiving Bore Through First Arm
90"	Spacing Adjustment Mechanism Receiving Threaded Bore in Second Arm
91'	Concave Channel Formed in Inner Surface of First Arm
91"	Concave Channel Formed in Inner Surface of Second Arm
100	Connector
101	Shank of Connector
102	Head of Connector
110	Washer
120	Spacing Adjustment Mechanism
121	Shank of Bolt
122	Head of Bolt
130	Tube-Receiving Frame
131	Axially Extending Rods of Tube-receiving Frame
140	Tubular Paint Applicator
x	Longitudinal Direction
y	Latitudinal Direction

z Transverse Direction

Construction

First Embodiment

One embodiment of the paint roller **10** is shown in Figures 1-4. The paint roller **10** includes a handle **20**, a shaft **30**, a flexure joint **50**, a connector **100**, and a tube-receiving frame **130**. The tube-receiving frame **130** is configured and arranged to accept a tubular paint applicator **140**. The second end **22** of the handle **20** is selectively secured to the first end section **31** of the shaft **30** by the flexure joint **50**. The tube-receiving frame **130** is rotatably secured to the second end **32** of the shaft **30**.

The handle **20** preferably includes a grip portion **23** and a neck portion **24**. The grip portion **23** may be constructed from any number of materials possessing the necessary structural integrity including specifically but not exclusively, aluminum, ceramic, wood and molded plastic. The grip portion **23** is preferably sized to comfortably rest within a user's hand (not shown). In this regard, the grip portion **23** may include finger articulations for enhancing fit with a user's hand. The neck portion **24** extends from the grip portion **23** at the second end **22** of the handle **20** and is preferably made of a rigid material, such as mild steel or stainless steel. The neck portion **24** of the handle **20** terminates at the flexure joint **50**. While the grip portion **23** and the neck portion **24** have been described as separate components, the handle **20** may be integrally formed of a single material. In fact, the neck portion **24** can be eliminated. The handle **20** can be configured and arranged with other shapes, sizes, configurations, and/or constructions known in the art.

The handle **20** preferably includes a threaded longitudinal bore **29** accessible from the first end **21** of the handle **20** for receiving and threadably engaging a standard extension pole (not shown).

The shaft **30** forms an appropriate U-shape, and includes a first end section **31**, a second end section **32,** and a U-shaped central section **33**. The first end section **31** is secured to a component of the flexure joint **50**. The second end section **32** is rotatably secured to the tube-receiving frame **130**. The shaft **30** is preferably a rigid rod, formed from any material possessing the necessary structural integrity such as aluminum, mild steel, stainless steel, and molded plastic. The shaft **30** can be configured with any desired configuration, but preferably approximates the ergonomic U-shape of the standard paint roller.

The tube-receiving frame **130** is of a type commonly known in the art and is rotatably secured to the second end **32** of the shaft **30**. In this regard, the tube-receiving frame **130** may include radial bearings (not shown) at either end of the tube-receiving frame **130** to provide rotatable association with the shaft **30**. The tube-receiving frame **130** preferably includes axially extending rods **131** sized to frictionally maintain the tubular paint applicator **140** in position. Other functional elements may also be secured to the second end **32** of the shaft **30** including specifically, but not exclusively, a sweeping brush, a wire brush, a scrapper, a painting pad, and a sanding pad.

The flexure joint **50** is configured to provide repositionable "locked" orientation of the shaft **30** relative to the handle **20**. The flexure joint **50** includes a spherical member **60**, a receiving member **80**, and a connector **100**. In a preferred embodiment, the spherical member **60** is attached at the free end (unnumbered) of the first end section **31** of the shaft **30** and the receiving member **80** is attached to the neck portion **24** of the handle **20**. Alternatively, attachment of the spherical member **60** and the receiving member **80** can be reversed, with the spherical member **60** attached to the neck portion **24** of the handle **20** and the receiving member **80** attached at the free end (unnumbered) of the first end section **31** of the shaft **30**. For purposes of enhancing lucidity of the disclosure, the balance of the detailed description shall be set forth in connection with the embodiment of the paint roller **10** in which the spherical member **60** is attached at the end of the first end section **31** of the shaft **30** and the receiving member **80** is attached to the neck portion **24** of the handle **20**. However, it is to be understood that the disclosure applies equally to the embodiment in which the spherical member **60** is attached to the

neck portion **24** of the handle **20** and the receiving member **80** attached at the free end (unnumbered) of the first end section **31** of the shaft **30**.

The spherical member **60** can be constructed from any material possessing the necessary structural integrity, such as a mild steel or stainless steel ball bearing. The spherical member **60** is preferably constructed from a slightly compressible material capable of structurally surviving the torsion forces placed upon the spherical member **60** during normal use of the paint roller **10**, such as a high durometer rubber. The spherical member **60** preferably has a diameter of approximately 0.687 inches, although other diameters are equally acceptable.

The spherical member **60** preferably has a radial bore (not shown) for accepting insertion of the free end (unnumbered) of the first end section **31** of the shaft **30** and thereby facilitating attachment of the shaft **30** to the spherical member **60**. The spherical member **60** can be attached by any of the attachment techniques known in the art, such as threading, adhesives, frictional fit, welding, etc. The spherical member **60** can also be integrally formed with the shaft **30**.

The receiving member **80** is shown in greater detail in Figures 3 and 4. In a preferred embodiment, the receiving member **80** is generally Y-shaped, defined by a shoulder portion **81** and a clamping portion **82**. The clamping portion **82** includes transversely spaced first and second arms, **83** and **84**, which longitudinally extend in a substantially uniform fashion from the shoulder portion **81**.

A threaded longitudinal bore **85** is preferably provided in the shoulder portion **81** of the receiving member **80** for threadably engaging the neck portion **24** of the handle **20**. A transverse pin passage **86** preferably extends through the shoulder portion **81** and through the longitudinal bore **85**. The transverse pin passage **86** is sized to receive and frictionally maintain a roll pin (not shown) for preventing unintentional loosening of the neck portion **24** from within the longitudinal bore **85** in the shoulder portion **81** of the receiving member **80**. Alternatively, the shoulder portion **81** of the receiving member **80** can be configured to accommodate other forms of attachment to the neck portion **24** of the handle **20** such as by a weld, adhesive, etc. With

these alternative configurations, one or both of the longitudinal bore **85** and the transverse pin passage **86** can be eliminated.

The clamping portion **82** of the receiving member **80** includes opposed first and second arms **83** and **84**, separated by a gap **87**. In this regard, arms **83** and **84** preferably extend in a substantially identical fashion from the shoulder portion **81** of the receiving member **80**. Each of the first arm **83** and second arm **84** has an inner surface **83i** and **84i**, and an outer surface **83o** and **84o**, respectively. Transversely aligned apertures **88', 88"**, and transversely aligned connector receiving bores **89'** and **89"** extend through the first and second arms **83** and **84**, respectively. The apertures **88'** and **88"** are longitudinally spaced from the connector receiving bores **89'** and **89"** towards the distal ends **83d** and **84d** of the first and second arms **83** and **84** respectively.

The first and second arms **83** and **84** are preferably formed such that the outer surfaces **83o** and **84o** of the arms **83** and **84** are substantially flat and have a width in the range of 0.5 - 1.5 inches, more preferably in the range of 0.75 - 1.25 inches, and most preferably approximately 1 inch. The inner surfaces **83i** and **84i** of the first and second arms **83** and **84** are also preferably substantially flat with mirror image longitudinally extending concave channels **91'** and **91"** formed by the inner surfaces **83i** and **84i** of each arm **83** and **84** respectively. The concave channels **91'** and **91"** are preferably formed as mirror images, with each channel **91'** and **91"** extending from the distal end **83d** and **84d** of the corresponding arm **83** and **84** to at least the apertures **88'** and **88"** in the corresponding arm **83** and **84**. The concave channels **91'** and **91"** are sized in accordance with the diameter of the spherical member **60** to facilitate initial introduction of the spherical member **60** into frictional engagement within the gap **87** between the arms **83** and **84** and transversely centered within the apertures **88'** and **88"**. Thus in a preferred embodiment, the transverse height of the gap **87** between the arms **83** and **84** is substantially less than the diameter of the spherical member **60** except at the nadirs (unnumbered) of the concave channels **91'** and **91"** where the transverse height of the gap **87** is only slightly smaller than the diameter of the spherical member **60** so as to facilitate initial introduction of the spherical member **60** within the gap **87** separating the arms **83** and **84** with the spherical member **60** transversely centered within the apertures **88'** and **88"** in the arms **83**

and **84**. Alternatively, other assembly techniques may be employed in which the concave channels **91'** and **91"** need not be formed.

As depicted in Figure 3, the gap **87** separates the first arm **83** and second arm **84** and extends the entire longitudinal length and lateral width of the clamping portion **82** of the receiving member **80**. The gap **87** preferably defines a distal region **87d** and a proximal region **87p** with the transverse height of the gap **87** in the distal region **87d** greater than the height of the gap **87** in the proximal region **87p**. In other words, the transverse spacing between the first arm **83** and the second arm **84** is greater within the distal region **87d** of the gap **87** than the proximal region **87p** of the gap **87**. The distal region **87d** preferably encompasses the apertures **88'** and **88"** and the connector receiving bores **89'** and **89"**. The transverse height of the distal region **87d** is selected to accommodate the spherical member **60** within the gap **87**, accommodate passage of the first end section **31** of the shaft **30** into the gap **87** and into engagement with the spherical member **60** retained within the gap **87**, and permit lateral pivoting of the first end section **31** of the shaft **30** within the gap **87**. More particularly, the transverse height of the distal region **87d** is preferably less than the diameter of the spherical member **60** such that the spherical member **60** is retainable between the first arm **83** and the second arm **84** when the connector **100** is in a disengaged condition. In addition, the transverse height of the distal region **87d**, the diameter of the spherical member **60** and the thickness of the first end section **31** of the shaft **30** are preferably selected so that the shaft **30** does not interfere with locking engagement of the spherical member **60** between the arms **83** and **84** by actuation of the connector **100**. Generally, a transverse height of approximately 0.4 inches is acceptable. Alternatively, other transverse heights are equally acceptable.

As described below, the gap **87** allows the first arm **83** and second arm **84** to be deflected toward or away from one another by actuation of the connector **100** so as to lock the spherical member **60** in position relative to the receiving member **80** when in an engaged condition and allow repositioning of the spherical member **60** relative to the receiving member **80** when in a disengaged condition. A variety of factors can impact the extent to which the first arm **83** and second arm **84** can be deflected, including the material of construction, the longitudinal length of the arms **83** and **84** defined by the longitudinal length of the gap **87**, the thickness of the first arm

83 and second arm **84** proximate the shoulder portion **81** of the receiving member **80**, the longitudinal placement of the apertures **88'** and **88"**, and the longitudinal placement of the connector receiving bores **89'** and **89"**. As shown in Figure 3, the gap **87** can be configured with a proximal region **87p** having a transverse height which is less than the transverse height of the distal region **87d** for purposes of increasing the longitudinal length of the gap **87** and thereby facilitating deflection of the arms **83** and **84**, while providing a strong clamping action. Alternatively, the gap **87** can be formed with a relatively uniform height along the entire longitudinal length of the gap **87**.

Transversely aligned and transversely extending apertures **88'** and **88"** are formed in the first and second arms **83** and **84** respectively. The apertures **88'** and **88"** are configured and arranged to receive and maintain the spherical member **60**. In a preferred embodiment, favored for ease of manufacture, the apertures **88'** and **88"** extend completely through the respective arm **83** and **84**. Alternatively, the apertures **88'** and **88"** may be formed as a cylindrical concavity which does not extend completely through the arms **83** or **84**, or may be formed as a dimple in the inner surface **83i** and **84i** of the respective arm **83** and **84**. The apertures **88'** and **88"** have a diameter which is smaller than the diameter of the spherical member **60** to prevent the spherical member **60** from passing completely through the apertures **88'** and **88"**. For example, a spherical member **60** having a diameter of 0.687 inches can be satisfactorily accommodated within apertures **88'** and **88"** having a diameter of 0.5 inches. Alternatively, other dimensions are equally acceptable.

The transversely aligned connector receiving bores **89'** and **89"** in the first and second arms **83** and **84** respectively, are longitudinally spaced from apertures **88'** and **88"** towards the shoulder portion **81** of the receiving member **80**. The connector receiving bores **89'** and **89"** are longitudinally spaced from apertures **88'** and **88"** a distance sufficient to prevent the connector **100** from contacting and interfering with rotation of the spherical member **60** when the connector **100** is operably positioned within the connector receiving bores **89'** and **89"**. However, the connector receiving bores **89'** and **89"** are preferably placed in relatively close longitudinal proximity to apertures **88'** and **88"** as the actuation force required to lock the spherical member **60** into position is reduced by positioning the connector **100** as close as possible to the distal

ends **83d** and **84d** of the arms **83** and **84** respectively. For example, a center to center spacing of about 0.625 inches from the connector receiving bores **89'** and **89"** to the corresponding apertures **88'** and **88"** in each arm **83** and **84** is effective when the spherical member **60** has a diameter of 0.5 inches and the shank **101** of the connector **100** has a diameter of 0.25 inches.

The connector receiving bores **89'** and **89"** are configured to selectively retain the connector **100** as between an engaged condition wherein the arms **83** and **84** are deflected towards one another and the spherical member **60** is locked in position, and a disengaged condition wherein the arms **83** and **84** are not deflected and the spherical member **60** can be rotatably repositioned relative to the receiving member **80**. For example, in one embodiment, the connector receiving bore **89'** through the first arm **83** slidably engages the shank **101** of the connector **100** while preventing passage of the head **102** of the connector **100**, while the connector receiving bore **89"** through the second arm **84** is threaded for threadably engaging the shank **101** of the connector **100**. Alternatively, other attachment configurations are equally acceptable.

The entire receiving member **80**, including the shoulder portion **81** and the clamping portion **82** is preferably a one-piece member integrally formed from a high strength deflectable material such as T6 aluminum.

The shaft **30** and thereby the tube-receiving frame **130** can be manually repositioned relative to the handle **20** after the connector **100** is loosened. The shaft **30** can be rotated about the longitudinal axis **20x** of the handle **20** by effecting rotation of the spherical member **60** about the longitudinal axis **60x** of the spherical member **60** within the receiving member **80**. In addition, the shaft **30** can be laterally repositioned relative to the handle **20** by effecting rotation of the spherical member **60** about the transverse axis **60z** of the spherical member **60** within the receiving member **80**. Transverse repositioning of the shaft **30** relative to the handle **20** is limited by arms **83** and **84**, which prevent continued transverse movement of the spherical member **60** because the distal ends **83d** and **84d** of the arms **83** and **84** contact the first end section **31** of the shaft **30**. Thus, the flexure joint **50** effectively provides two degrees of freedom of movement.

The flexure joint **50** can be configured and arranged to allow (i) 360° rotation of the shaft **30** about the longitudinal axis **20x** of the handle **20**, and (ii) at least a 30°, preferably at least a 60°, and most preferably at least a 90°, rotation of the shaft **30** about the transverse axis **60z** of the spherical member **60** in both clockwise and counter-clockwise directions from the longitudinal axis **20x** of the handle **20.**

Once the shaft **30** and thus the tube-receiving frame **130** and tubular paint applicator **140** is located in the desired angular and rotational position relative to the handle **20**, the shaft **30** can be locked into position by tightening the connector **100** so as to lock the spherical member **60** into position within the clamping portion **82** of the receiving member **80**. The paint roller **10** is then available for use.

The tube-receiving frame **130** and tubular paint applicator **140** can be quickly and easily repositioned relative to the handle **20** by loosening the connector **100,** effecting the desired amount of rotational and angular repositioning of the shaft **30** relative to the receiving member **80**, and then retightening the connector **100.**

The paint roller **10** with flexure joint **50** of the present invention provides a marked improvement over the standard paint roller design. By providing a user with the ability to easily change orientation of an attached tubular paint applicator **140** relative to the handle **20**, a wide variety of new applications for the paint roller **10** are now available. For example, a simple rotation of the shaft **30** relative to the handle **20** facilitates painting a corner. Additionally, transversely angling the tubular paint applicator **140** from the longitudinal axis **20x** of the handle **20** facilitates the horizontal painting of elevated surfaces. Finally, the ability to adjust the position of the tubular paint applicator **140** relative to the handle **20** allows the paint roller **10** to be used in a more ergonomically correct position for a variety of painting directions and positions, thus minimizing the stresses placed upon the wrist, arm, shoulder and back of a user.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art recognize that changes may be made in form and detail

without departing from the spirit and scope of the invention. For example, the paint roller **10** of the present invention has been described as relating to a standard size. It would be recognized by those skilled in the art that the paint roller **10** can be constructed to substantially any desired sized. In addition, the paint roller **10** may utilize a shaft **30**, which does not have the standard U-shaped section **33**. Similarly, while the spherical member **60** has been described as round with a smooth surface, other shapes and surface textures, such as an egg shaped member with a knurled surface, may also be employed.

In light of the disclosure provided herein, other options for providing the desired lateral repositionability of the shaft **30** relative to the handle **20** would be known to those skilled in the art. One such option is replacement of the spherical member **60** and associated apertures **88'** and **88"** in the arms **83** and **84** with a spindle (not shown) rotatably mounted within bearings (not shown) in the arms **83** and **84**. The spindle version would further replace the connector **100** and connector receiving bores **89'** and **89"** in the arms **83** and **84** with a releasable catch system such as a ratchet-type assembly (not shown) or a pin retention system (not shown) for locking the spindle into position.

It is not necessary that the flexure joint **50** provide the multiple degrees of freedom offered by the preferred embodiments disclosed herein. The claimed invention includes paint rollers **10** having a flexure joint **50**, which provides a single degree of freedom.

Second Embodiment

A second embodiment of the paint roller **10** is shown in Figures 5 through 17. The second embodiment of the paint roller **10** is similar in many respects to the first embodiment of the paint roller **10**. Accordingly, similar components and features will be identified by the same reference numeral.

Referring to Figure 5, the paint roller **10** includes a handle **20**, a shaft **30**, a locking mechanism **40**, a flexure joint **50**, a connector **100**, a spacing adjustment mechanism **120**, and a tube-receiving frame **130**. The tube-receiving frame **130** is configured and arranged to accept a

tubular paint applicator **140**. The second end **22** of the handle **20** is selectively secured to the first end section **31** of the shaft **30** by the flexure joint **50**. The tube-receiving frame **130** is rotatably secured to the second end **32** of the shaft **30**.

The handle **20** preferably includes a grip portion **23** and a neck portion **24**. The grip portion **23** may be constructed from any number of materials possessing the necessary structural integrity including specifically but not exclusively, aluminum, ceramic, wood and molded plastic. The grip portion **23** is preferably sized to comfortably rest within a user's hand (not shown). In this regard, the grip portion **23** may include finger articulations for enhancing fit with a user's hand. The neck portion **24** extends from the grip portion **23** at the second end **22** of the handle **20** and is preferably made of a rigid material, such as mild steel or stainless steel. The neck portion **24** of the handle **20** terminates at the flexure joint **50**. While the grip portion **23** and the neck portion **24** have been described as separate components, the handle **20** may be integrally formed of a single material. In fact, the neck portion **24** can be eliminated. The handle **20** can be configured and arranged with other shapes, sizes, configurations, and/or constructions known in the art.

The handle **20** preferably includes a threaded longitudinal bore **29** accessible from the first end **21** of the handle **20** for receiving and threadably engaging a standard extension pole (not shown).

The shaft **30** forms an appropriate U-shape, and includes a first end section **31**, a second end section **32**, and a U-shaped central section **33**. The first end section **31** is secured to a component of the flexure joint **50**. The second end section **32** is rotatably secured to the tube-receiving frame **130**. The shaft **30** is preferably a rigid rod, formed from any material possessing the necessary structural integrity such as aluminum, mild steel, stainless steel, and molded plastic. The shaft **30** can be configured with any desired configuration, but preferably approximates the ergonomic U-shape of the standard paint roller.

The tube-receiving frame **130** is of a type commonly known in the art and is rotatably secured to the second end **32** of the shaft **30**. In this regard, the tube-receiving frame **130** may

include radial bearings (not shown) at either end of the tube-receiving frame **130** to provide rotatable association with the shaft **30**. The tube-receiving frame **130** preferably includes axially extending rods **131** sized to frictionally maintain the tubular paint applicator **140** in position. Other functional elements may also be secured to the second end **32** of the shaft **30** including specifically, but not exclusively, a sweeping brush, a wire brush, a scrapper, a painting pad, and a sanding pad.

The flexure joint **50** is configured to provide repositionable "locked" orientation of the shaft **30** relative to the handle **20**. The flexure joint **50** includes a spherical member **60**, a collar **70**, a receiving member **80**, a connector **100**, and a spacing adjustment mechanism **120**. In a preferred embodiment, the spherical member **60** is attached to the free end (unnumbered) of the first end section **31** of the shaft **30** and the receiving member **80** is attached to the neck portion **24** of the handle **20**. Alternatively, attachment of the spherical member **60** and the receiving member **80** can be reversed, with the spherical member **60** attached to the neck portion **24** of the handle **20** and the receiving member **80** attached to the free end (unnumbered) of the first end section **31** of the shaft **30**. For purposes of enhancing lucidity of the disclosure, the balance of the detailed description shall be set forth in connection with the embodiment of the paint roller **10** in which the spherical member **60** is attached to the free end (unnumbered) of the first end section **31** of the shaft **30** and the receiving member **80** is attached to the neck portion **24** of the handle **20**. However, it is to be understood that the disclosure applies equally to the embodiment in which the spherical member **60** is attached to the neck portion **24** of the handle **20** and the receiving member **80** attached to the free end (unnumbered) of the first end section **31** of the shaft **30**.

The spherical member **60** can be constructed from any material possessing the necessary structural integrity, such as a mild steel or stainless steel ball bearing. The spherical member **60** is preferably constructed from a slightly compressible material capable of structurally surviving the torsion forces placed upon the spherical member **60** during normal use of the paint roller **10**, such as a high durometer rubber. The spherical member **60** preferably has a diameter of approximately 0.687 inches, although other diameters are equally acceptable.

The spherical member **60** can de directly attached to the free end (unnumbered) of the first end section **31** of the shaft **30**. In a preferred embodiment, the spherical member **60** is molded around a radially extending collar **70** with a radially extending threaded bore **79** provided in the collar **70** for threadably engaging the free end (unnumbered) of the first end section **31** of the shaft **30** and thereby providing rotatable attachment of the shaft **30** to the spherical member **60**.

A locking mechanism **40** is provided for locking the shaft **30** in a selected rotational position about the longitudinal axis **60x** of the spherical member **60** when in an engaged condition and allow rotational repositioning of the shaft **30** about the longitudinal axis **60x** of the spherical member **60** without rotation of the spherical member **60** when in a disengaged condition. A preferred locking mechanism **40**, shown in Figures 5, 11 and 17, is a wing nut **40** having a longitudinal threaded bore (not shown) extending completely through the wing nut **40** for threadably engaging the threaded first end section **31** of the shaft **30**. The wing nut **40** is effective for locking the shaft **30** in a selected rotational position about the longitudinal axis **60x** of the spherical member **60** by rotating the wing nut **40** in a first direction relative to the first end section **31** of the shaft **30** until the distal end **41** of the wing nut **40** engages the collar **70**. The wing nut **40** can be disengaged for allow rotational repositioning of the shaft **30** about the longitudinal axis **60x** of the spherical member **60** by simply rotating the wing nut **40** in a reverse direction relative to the first end portion **31** of the shaft **30** until the distal end **41** of the wing nut **40** disengages the collar **70**.

The receiving member **80** is shown in greater detail in Figures 8 through 11. In a preferred embodiment, the receiving member **80** is generally Y-shaped, defined by a shoulder portion **81** and a clamping portion **82**. The clamping portion **82** includes transversely spaced first and second arms, **83** and **84**, which longitudinally extend in a substantially uniform fashion from the shoulder portion **81**.

A threaded longitudinal bore **85** is preferably provided in the shoulder portion **81** of the receiving member **80** for threadably engaging the neck portion **24** of the handle **20**.

The clamping portion **82** of the receiving member **80** includes opposed first and second arms **83** and **84**, separated by a gap **87**. In this regard, arms **83** and **84** preferably extend in a substantially identical fashion from the shoulder portion **81** of the receiving member **80**. Each of the first arm **83** and second arm **84** has an inner surface **83i** and **84i**, and an outer surface **83o** and **84o**, respectively. Transversely aligned apertures **88'** and **88"**, transversely aligned connector receiving bores **89'** and **89"**, and transversely aligned spacing adjustment mechanism receiving bores **90'** and **90"**extend through the first and second arms **83** and **84**, respectively. The apertures **88'** and **88"** are longitudinally spaced from the connector receiving bores **89'** and **89"** towards the distal ends **83d** and **84d** of the first and second arms **83** and **84** respectively. The adjustment mechanism receiving bores **90'** and **90"**are longitudinally spaced from the connector receiving bores **89'** and **89"** towards the proximal ends **83p** and **84p** of the first and second arms **83** and **84** respectively.

The first and second arms **83** and **84** are preferably formed such that the outer surfaces **83o** and **84o** of the arms **83** and **84** are substantially flat and have a width in the range of 0.5 - 1.5 inches, more preferably in the range of 0.75 - 1.25 inches, and most preferably approximately 1 inch. The inner surfaces **83i** and **84i** of the first and second arms **83** and **84** are also preferably substantially flat with mirror image longitudinally extending concave channels **91'** and **91"** formed by the inner surfaces **83i** and **84i** of each arm **83** and **84** respectively. The concave channels **91'** and **91"** are preferably formed as mirror images, with each channel **91'** and **91"** extending from the distal ends **83d** and **84d** of the corresponding arm **83** and **84** to at least the apertures **88'** and **88"** in the corresponding arm **83** and **84**. The concave channels **91'** and **91"** are sized in accordance with the diameter of the spherical member **60** to facilitate initial introduction of the spherical member **60** into frictional engagement within the gap **87** between the arms **83** and **84** and transversely centered within the apertures **88'** and **88"**. Thus in a preferred embodiment, the transverse height of the gap **87** between the arms **83** and **84** is substantially less than the diameter of the spherical member **60** except at the nadirs (unnumbered) of the concave channels **91'** and **91"** where the transverse height of the gap **87** is only slightly smaller than the diameter of the spherical member **60** so as to facilitate initial introduction of the spherical member **60** within the gap **87** separating the arms **83** and **84** with the spherical member **60** transversely centered within the apertures **88'** and **88"** in the arms **83**

and **84**. Alternatively, other assembly techniques may be employed in which the concave channels **91'** and **91"** need not be formed.

As depicted in Figures 8 and 11, the gap **87** separates the first arm **83** and second arm **84** and extends the entire longitudinal length and lateral width of the clamping portion **82** of the receiving member **80**. The gap **87** preferably defines a distal region **87d**, a middle region **87m** and a proximal region **87p** with the transverse height of the gap **87** in the distal region **87d** greater than the height of the gap **87** in the middle region **87m** and the transverse height of the gap **87** in the proximal region **87p** greater than the height of the gap **87** in the distal region **87d**. In other words, the transverse spacing between the first arm **83** and the second arm **84** is greatest in the proximal region **87p** and least in the middle region **87m**. The distal region **87d** preferably encompasses the apertures **88'** and **88"** and the connector receiving bores **89'** and **89"**, while the middle region **87m** preferably encompasses the adjustment mechanism receiving bores **90'** and **90"**. The transverse height of the distal region **87d** is selected to accommodate the spherical member **60** within the gap **87**, accommodate passage of the collar **70** and the first end section **31** of the shaft **30** into the gap **87** and into engagement with the spherical member **60** retained within the gap **87**, and permit lateral pivoting of the collar **70** and the first end section **31** of the shaft **30** within the gap **87**. More particularly, the transverse height of the distal region **87d** is preferably less than the diameter of the spherical member **60** such that the spherical member **60** is retainable between the first arm **83** and the second arm **84** when the connector **100** is in a disengaged condition. In addition, the transverse height of the distal region **87d**, the diameter of the spherical member **60** and the thickness of the first end section **31** of the shaft **30** are preferably selected so that the shaft **30** does not interfere with locking engagement of the spherical member **60** between the arms **83** and **84** by actuation of the connector **100**. Generally, a transverse height of approximately 0.4 inches is acceptable. Alternatively, other transverse heights are equally acceptable.

As described below, the gap **87** allows the first arm **83** and second arm **84** to be deflected toward or away from one another by (i) actuation of the connector **100** so as to lock the spherical member **60** in position relative to the receiving member **80** when in an engaged condition and allow repositioning of the spherical member **60** relative to the receiving member **80** when in a

disengaged condition, and (ii) actuation of the spacing adjustment mechanism **120** so as to adjustment the transverse height of the distal region **87d** of the gap **87** from time to time and thereby maintain a desired tolerance between the diameter of the spherical member **60** and the height of the distal region **87d** of the gap **87** as the components are subjected to wear and tear. A variety of factors can impact the extent to which the first arm **83** and second arm **84** can be deflected by the connector **100**, including the material of construction, the longitudinal length of the arms **83** and **84** defined by the longitudinal length of the gap **87**, the thickness of the first arm **83** and second arm **84** proximate the shoulder portion **81** of the receiving member **80**, the longitudinal placement of the apertures **88'** and **88"**, the longitudinal placement of the connector receiving bores **89'** and **89"**, and the longitudinal placement of the spacing adjustment receiving bores **90'** and **90"**. As shown in Figures 8 and 11, the gap **87** can be configured with a proximal region **87p** for purposes of facilitating deflection of the arms **83** and **84** towards one another when the spacing adjustment mechanism **120** is actuated (*i.e.*, tightened). Alternatively, the gap **87** can be formed with a relatively uniform height along the entire longitudinal length of the gap **87**.

Transversely aligned and transversely extending apertures **88'** and **88"** are formed in the first and second arms **83** and **84** respectively. The apertures **88'** and **88"** are configured and arranged to receive and maintain the spherical member **60**. In a preferred embodiment, favored for ease of manufacture, the apertures **88'** and **88"** extend completely through the respective arm **83** and **84**. Alternatively, the apertures **88'** and **88"** may be formed as a cylindrical concavity which does not extend completely through the arm **83** or **84**, or may be formed as a dimple in the inner surfaces **83i** and **84i** of the respective arms **83** and **84**. The apertures **88'** and **88"** have a diameter which is smaller than the diameter of the spherical member **60** to prevent the spherical member **60** from passing completely through the apertures **88'** and **88"**. For example, a spherical member **60** having a diameter of 0.687 inches can be satisfactorily accommodated within apertures **88'** and **88"** having a diameter of 0.5 inches. Alternatively, other dimensions are equally acceptable.

The transversely aligned connector receiving bores **89'** and **89"** in the first and second arms **83** and **84** respectively, are longitudinally spaced from apertures **88'** and **88"** towards the

shoulder portion **81** of the receiving member **80**. The connector receiving bores **89'** and **89"** are longitudinally spaced from apertures **88'** and **88"** a distance sufficient to prevent the connector **100** from contacting and interfering with rotation of the spherical member **60** when the connector **100** is operably positioned within the connector receiving bores **89'** and **89"**. However, the connector receiving bores **89'** and **89"** are preferably placed in relatively close longitudinal proximity to apertures **88'** and **88"** as the actuation force required to lock the spherical member **60** into position is reduced by positioning the connector **100** as close as possible to the distal ends **83d** and **84d** of the arms **83** and **84** respectively. For example, a center to center spacing of about 0.625 from the connector receiving bores **89'** and **89"** to the corresponding apertures **88'** and **88"** in each arm **83** and **84** is effective when the spherical member **60** has a diameter of 0.5 inches and the shank **101** of the connector **100** has a diameter of 0.25 inches.

The connector receiving bores **89'** and **89"** are configured to selectively retain the connector **100** as between an engaged condition wherein the arms **83** and **84** are deflected towards one another and the spherical member **60** is locked in position, and a disengaged condition wherein the arms **83** and **84** are not deflected and the spherical member **60** can be rotatably repositioned relative to the receiving member **80**. For example, in one embodiment, the connector receiving bore **89'** through the first arm **83** slidably engages the shank **101** of the connector **100** while preventing passage of the head **102** of the connector **100**, while the connector receiving bore **89"** through the second arm **84** is threaded for threadably engaging the shank **101** of the connector **100**. Alternatively, other attachment configurations are equally acceptable.

The transversely aligned spacing adjustment bores **90'** and **90"** in the first and second arm **83** and **84** respectively, are longitudinally spaced from the connector receiving bores **89'** and **89"** towards the shoulder portion **81** of the receiving member **80**. The spacing adjustment bores **90'** and **90"** are longitudinally spaced from the connector receiving bores **89'** and **89"** a distance effective for ensuring that users can readily attain the actuation force required to lock the spherical member **60** into position by hand actuation of the connector **100**. For example, a center to center spacing of about 0.75 inches from the spacing adjustment bores **90'** and **90"** to the corresponding connector receiving bores **89'** and **89"** in each arm **83** and **84** is generally

effective when the arms **83** and **84** are constructed from aluminum and have a lateral thickness of 0.5 inches in the distal region **87d** of the gap **87**.

The spacing adjustment bores **90'** and **90"** are configured to retain the spacing adjustment mechanism **120** and allow a periodic decrease in the transverse height of the distal region **87d** of the gap **87** to compensate for wear and tear of the components by actuation of the spacing adjustment mechanism **120**. For example, in one embodiment, the spacing adjustment bore **90'** through the first arm **83** slidably engages the shank **121** of the spacing adjustment mechanism **120** while preventing passage of the head **122** of the spacing adjustment mechanism **120**, while the spacing adjustment bore **90"** through the second arm **84** is threaded for threadably engaging the shank **121** of the spacing adjustment mechanism **120**. Alternatively, other attachment configurations are equally acceptable.

The entire receiving member **80**, including the shoulder portion **81** and the clamping portion **82** is preferably a one-piece member integrally formed from a high strength deflectable material such as T6 aluminum.

The shaft **30** and thereby the tube-receiving frame **130** can be manually repositioned relative to the handle **20** after the locking mechanism **40** and/or the connector **100** is loosened. Upon loosening the locking mechanism **40**, the shaft **30** can be rotated about the longitudinal axis **20x** of the handle **20** by effecting rotation of the first end **31** of the shaft **30** within the collar **70** retained within the spherical member **60**. Upon loosening the connector**100**, the shaft **30** can be laterally repositioned relative to the handle **20** by effecting rotation of the spherical member **60** about the transverse axis **60z** of the spherical member **60** within the receiving member **80**. Transverse repositioning of the shaft **30** relative to the handle **20** is limited by arms **83** and **84**, which prevent continued transverse movement of the spherical member **60** when the distal ends **83d** and **84d** of the arms **83** and **84** contact the collar **70** or first end section **31** of the shaft **30**.

The combination of the first end **31** of the shaft **30**, the collar **70** and the locking mechanism **40** can be configured, arranged and connected to allow 360° rotation of the shaft **30** about the longitudinal axis **20x** of the handle **20**.

The flexure joint **50** can be configured and arranged to allow at least a 30°, preferably at least a 60°, and most preferably at least a 90°, rotation of the shaft **30** about the transverse axis **60z** of the spherical member **60** in both clockwise and counter-clockwise directions from the longitudinal axis **20x** of the handle **20**.

Once the shaft **30** and thus the tube-receiving frame **130** and tubular paint applicator **140** is located in the desired angular and rotational position relative to the handle **20**, the shaft **30** can be locked into position by tightening the locking mechanism **40** and the connector **100** so as to lock the spherical member **60** into position within the clamping portion **82** of the receiving member **80**. The paint roller **10** is then available for use.

The tube-receiving frame **130** and tubular paint applicator **140** can be quickly and easily repositioned relative to the handle **20** by loosening one or both of the locking mechanism **40** and the connector **100**, depending upon the need to rotate about shaft **30** about the longitudinal **20x** and/or transverse **20z** axes of the handle **20** to achieve the desired repositioning, effecting the desired amount of rotation of the shaft **30** relative to the receiving member **80**, and then retightening the locking mechanism **40** and/or connector **100**.

The paint roller **10** with flexure joint **50** of the present invention provides a marked improvement over the standard paint roller design. By providing a user with the ability to easily change orientation of an attached tubular paint applicator **140** relative to the handle **20**, a wide variety of new applications for the paint roller **10** are now available. For example, a simple rotation of the shaft **30** relative to the handle **20** facilitates painting a corner. Additionally, transversely angling the tubular paint applicator **140** from the longitudinal axis **20x** of the handle **20** facilitates the horizontal painting of elevated surfaces. Finally, the ability to adjust the position of the tubular paint applicator **140** relative to the handle **20** allows the paint roller **10** to be used in a more ergonomically correct position for a variety of painting directions and positions, thus minimizing the stresses placed upon the wrist, arm, shoulder and back of a user.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. For example, the paint roller **10** of the present invention has been described as relating to a standard size. It would be recognized by those skilled in the art that the paint roller **10** can be constructed to substantially any desired sized. In addition, the paint roller **10** may utilize a shaft **30**, which does not have the standard U-shaped section **33**. Similarly, while the spherical member **60** has been described as round with a smooth surface, other shapes and surface textures, such as an egg shaped member with a knurled surface, may also be employed.

In light of the disclosure provided herein, other options for providing the desired lateral repositionability of the shaft **30** relative to the handle **20** would be known to those skilled in the art. One such option is replacement of the spherical member **60** and associated apertures **88'** and **88"** in the arms **83** and **84** with a spindle (not shown) rotatably mounted within bearings (not shown) in the arms **83** and **84**. The spindle version would further replace the connector **100** and connector receiving bores **89'** and **89"** in the arms **83** and **84** with a releasable catch system such as a ratchet-type assembly (not shown) or a pin retention system (not shown) for locking the spindle into position.

It is not necessary that the flexure joint **50** provide the multiple degrees of freedom offered by the preferred embodiments disclosed herein. The claimed invention includes paint rollers **10** having a flexure joint **50**, which provides fewer degrees of freedom.